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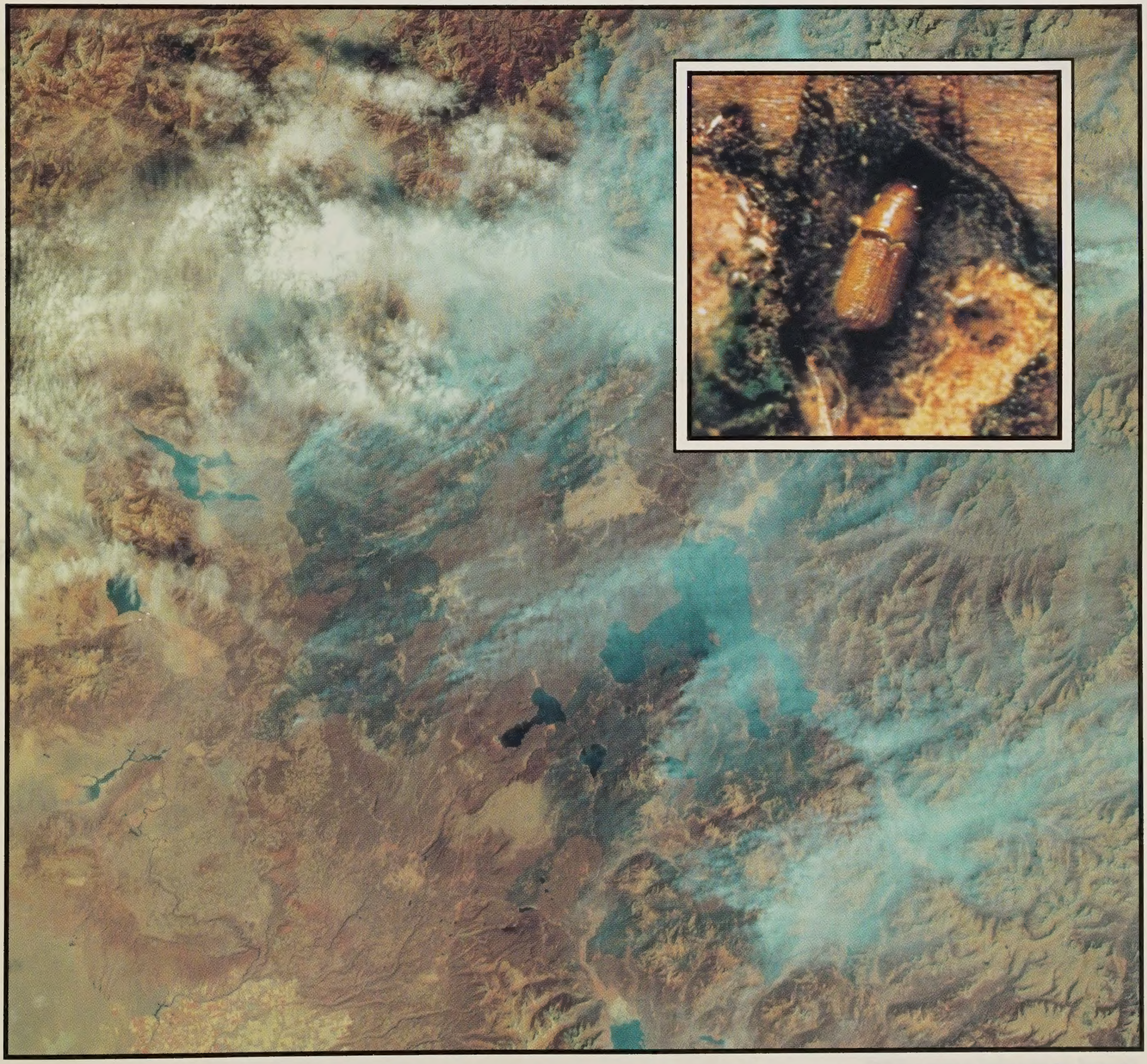
A Sequence of Destruction: Mountain Pine Beetle and Wildfire

Yellowstone National Park



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Cover: Satellite image taken on September 8, 1988, showing wildfires in Yellowstone National Park.

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A Sequence of Destruction: Mountain Pine Beetle and Wildfire

Yellowstone National Park

Douglas L. Parker and
Lawrence E. Stipe

Abstract

A mountain pine beetle infestation started in logdepole forests on the Targhee National Forest in the late 1950s and spread into Yellowstone National Park in 1966. It moved into higher elevation whitebark pine forests in subsequent years. Since little reliable information existed on the build up and effects of outbreaks, two trend plots were established along the western border of Yellowstone National Park to measure annual tree losses through the infestation cycle. One plot was located in an almost pure lodgepole pine forest at 6,400 feet elevation and another was established at about 8,400 feet in a mixed forest of lodgepole pine and whitebark pine. Tree losses were measured for several years until the infestations subsided. In subsequent years, however, natural and man-caused forces significantly altered the forests in and near the trend plots. These changes included: A resurgence of the beetle outbreak in the Park in 1979, clearcutting of beetle-damaged stands along much of the western border of the Park (cover), and the massive wildfires that burned over a half million areas of forest in 1988. In response to these changes, we decided to resample the trend plots in 1990 to further document the aftermath of the beetle outbreak from 1966 to 1984.

Both authors were entomologists in the Intermountain Region, Ogden, Utah, when the trend plots were established. Presently, Douglas L. Parker is in the Southwestern Region in Albuquerque, New Mexico, and Lawrence E. Stipe is in the Northern Region, Missoula, Montana.

Contents

List of Figures

List of Tables

Introduction

A mountain pine beetle (MPB), *Dendroctonus ponderosae* Hopk., outbreak started in lodgepole pine, *Pinus contorta* Dougl., stands on the Targhee National Forest in eastern Idaho in the late 1950s, intensified for several years, and eventually spread into the southwestern corner of Yellowstone National Park in 1966 (2) (Figure 1). Since little reliable information was available to indicate potential tree mortality during this outbreak, permanent sample plots were established to determine yearly beetle-caused mortality by diameter class. Plots were located in the extreme southwestern corner of the Park, near Bechler Meadows, elevation 6,400 feet. This site was selected because annual tree losses, in this almost pure lodgepole pine forest, could be measured in a relatively natural setting without direct influences of logging and chemical control measures. Mortality was recorded each year from 1966 until 1972. Sampling was terminated when beetle-caused tree losses had subsided to a low level (8).

In subsequent years, the beetle infestation continued to spread to higher elevation stands in the Park and Targhee National Forest (7). A second sample area near Split Creek was established to determine the mortality trend in a high-elevation stand (8,400 feet). Researchers had reported that climate was the most important factor influencing the biology of the beetles, and subsequent mortality and percentage of trees killed decreased with increasing elevation (1 and 9). This area was about 22 miles north of Bechler Meadows.

Stand conditions also were different from the Bechler Meadow plots. Two host tree species—lodgepole pine and whitebark pine *(Pinus albicaulis Engelm.)*—and two non-host species—alpine fir (*Abies lasiocarpa*) and engleman spruce (*Picea engelmannii*)—were present.

Again, the objective was to measure annual tree mortality from the beginning to the end of the outbreak. The infestation was followed for 6 years.

In 1990, we resampled stands in both areas to measure additional tree mortality following the initial outbreak. The Bechler Meadows plot was sampled on August 14 and the Split Creek plot on August 15, 1990. This report documents the results of that follow-up sampling.

Figure 1. Lodgepole pine mortality at Bechler Meadows, 1969.

Background

Bechler Meadows Plot, Initial Surveys

Methods

Sampling was done within a 640-acre area (2 miles by one-half mile) in the southwest corner of Yellowstone National Park, at an elevation of 6,400 feet (Figure 2). In 1968, 85 permanent plot centers were established in a grid pattern at 10-chain intervals on 5 lines (17 plots per line). Lines were located on true west and east bearings, corrected at 18 degrees declination. The starting point was the northeast corner of sample area. In fall 1968, live trees were sampled on every other plot and line, beginning at the first plot, and on three of five lines. Twenty seven plots in all were sampled.

Beetle-killed trees were recorded on all 85 plots each year sampling was done. However, attacks from the first 3 years were recorded in 1968—1968 current attacks, 1967 mortality (faders), and all other beetle-killed trees—which were classified as 1966 mortality. Aerial detection records for the neighboring Targhee National Forest showed that tree killing started in the southwestern portion of the Park in 1966 (2).

The variable plot method of cruising was used, with a basal area factor (BAF) of 10 to record live trees and a 5 BAF for mortality plots.

Results

In 1965, before MPB infestation reached the study area, there were an estimated 211 live lodgepole pines per acre, 5 inches diameter at breast height (d.b.h.), and larger. The number of live trees per acre was reduced to 156 in 1972 (Table 1, Figure 3); 74 percent being still alive. Only 29 percent of the trees larger than 12 inches d.b.h. survived, but many smaller trees were left to perpetuate the lodgepole pine

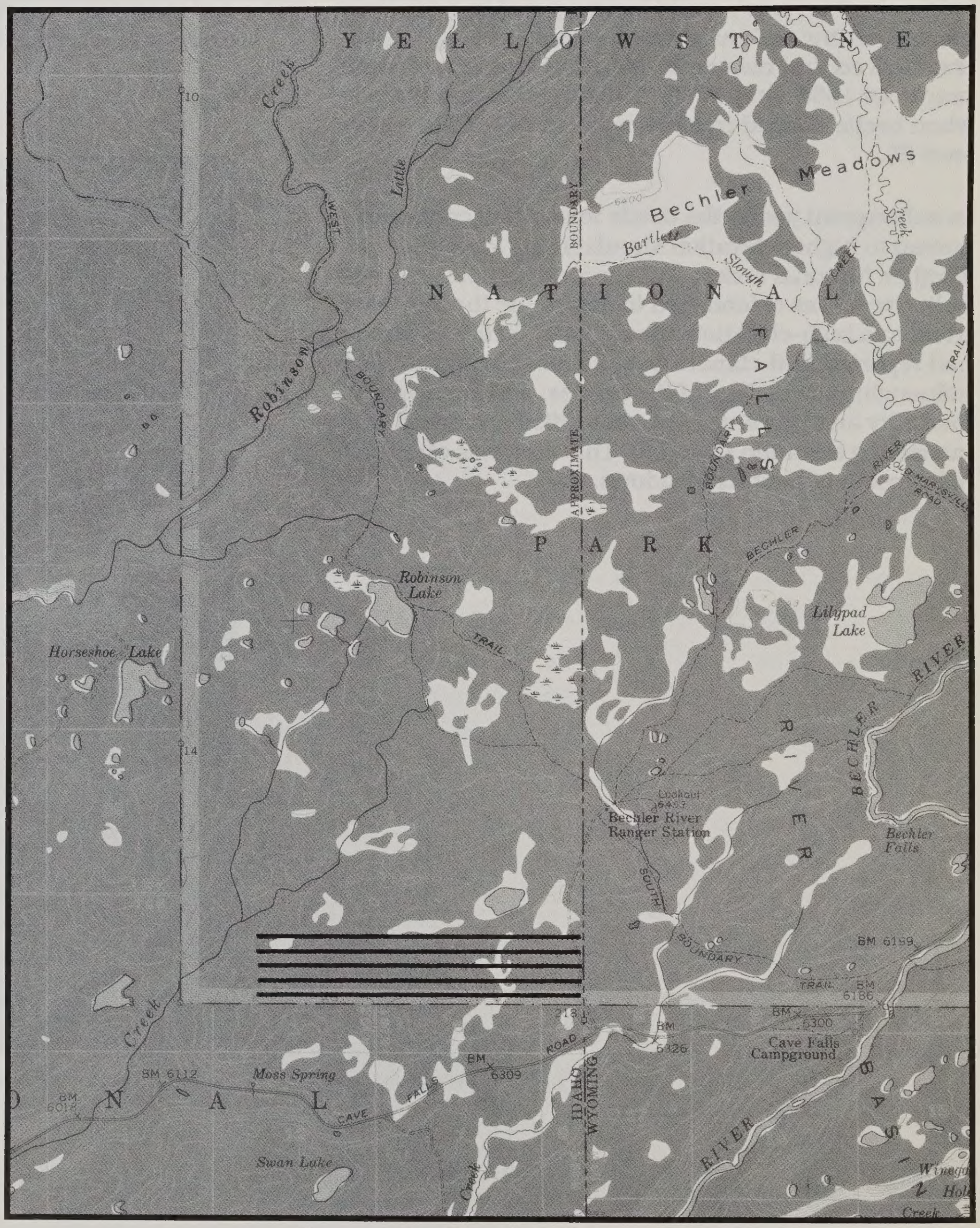


Figure 2. Location of Bechler Meadows Plot in the southwestern corner of Yellowstone National Park.

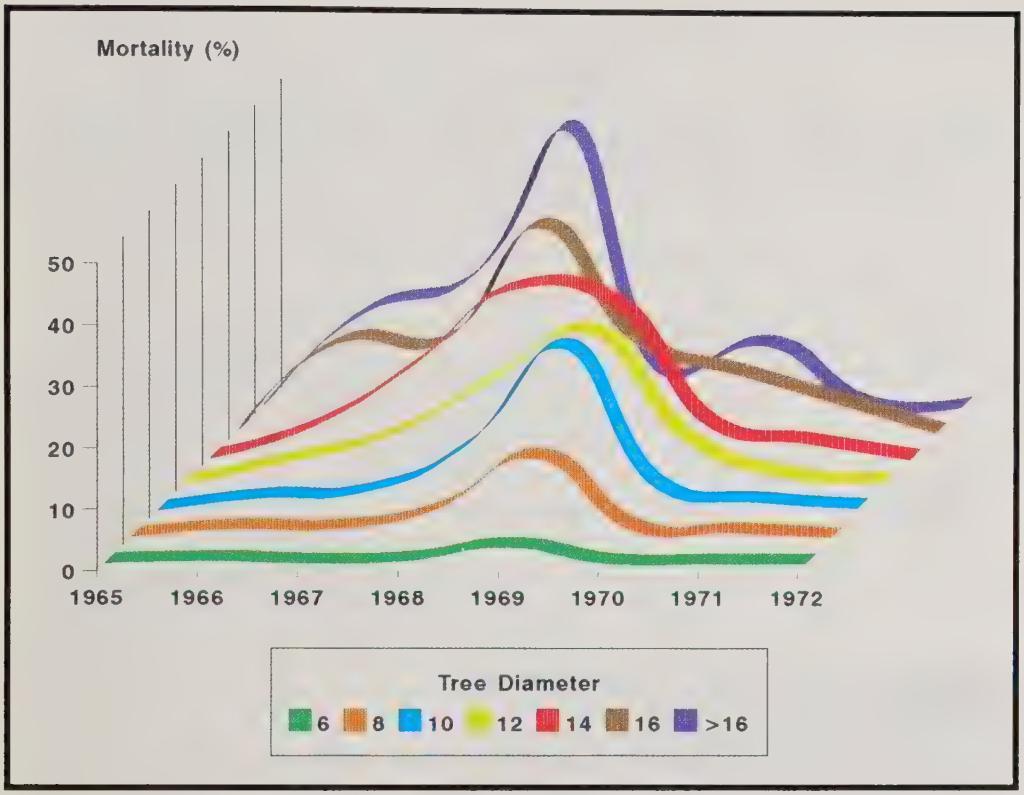


Figure 3. Tree mortality by 2-inch diameter class for 1965 to 1972 at Bechler Meadows.

forest. Percent survival would be higher if trees below 5 inches d.b.h. had been included.

Mountain pine beetle killed approximately 56 trees per acre in the study area during the 7-year infestation (Table 1, Figure 4). Peak mortality, 27 trees per acre, occurred during the fourth year (1969) of the outbreak. Incidentally, this annual mortality level was one of the highest ever documented in the Intermountain area at that time. During any one year, more smaller trees were killed then larger ones; but, larger trees were killed first, and at a rate disproportionate to their occurrence. Sizable decreases in tree killing occurred in 1970, 1971, and 1972. The largest change in the rate of annual tree mortality occurred from 1967 to 1968; a 2.6-fold increase. This led to peak mortality in 1969.

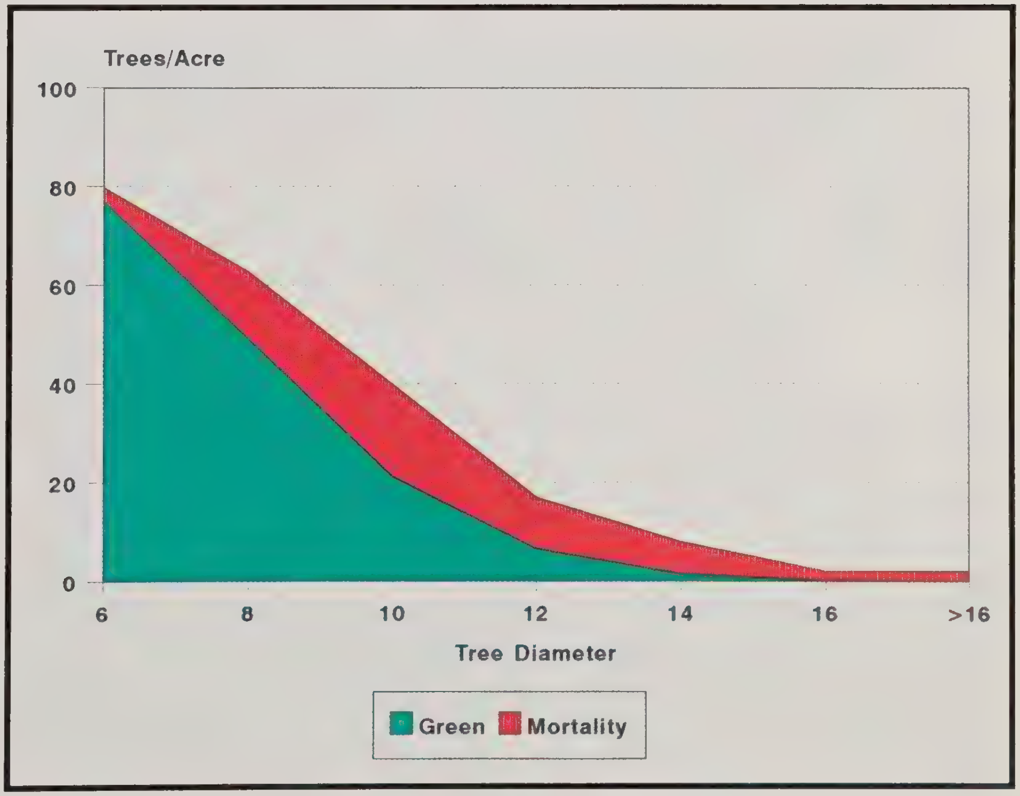


Figure 4. Cumulative tree mortality by 2-inch diameter class at Bechler Meadows.

Diameter Class In Inches[1]		Year								
		1965[2]	1966	1967	1968	1969	1970	1971	1972	Total
6	Live	79.8	79.5	79.5	79.2	77.1	77.1	77.1	77.1	77.1
	Dead	---	0.3	---	0.3	2.1	---	---	---	2.7
8	Live	62.7	61.9	61.1	58.4	50.3	49.6	49.1	49.1	49.1
	Dead	---	0.8	0.8	2.7	8.1	0.7	0.5	---	13.6
10	Live	39.8	39.0	37.9	34.0	23.4	22.0	21.4	21.2	21.2
	Dead	---	0.8	1.1	3.9	10.6	1.4	0.6	0.2	18.6
12	Live	7.0	16.4	15.1	12.3	8.1	6.9	6.7	6.6	6.6
	Dead	---	0.6	1.3	2.8	4.2	1.2	0.2	0.1	10.4
14	Live	8.0	7.6	6.4	4.2	2.2	1.8	1.6	1.6	1.6
	Dead	---	0.4	1.2	2.2	2.0	0.4	0.2	---	6.4
16	Live	2.1	1.8	1.5	0.8	0.5	0.3	0.2	0.2	0.2
	Dead	---	0.3	0.3	0.7	0.3	0.2	0.1	---	1.9
>16	Live	2.0	1.7	1.3	0.4	0.3	0.1	0.1	0.1	0.1
	Dead	---	0.3	0.4	0.9	0.1	0.2	---	---	1.9
Total	Live	211.4	207.9	202.8	189.3	161.9	157.8	156.2	155.9	155.9
	Dead	---	3.5	5.1	13.5	27.4	4.1	1.6	0.3	55.5

[1] Average values.

[2] Pre-outbreak stand structure.

Table 1. Number per acre of live trees and trees killed by the Mountain Pine Beetle in the Bechler Meadow Survey Area during an outbreak, 1966-72 (8).

Split Creek Plot, Initial Surveys

Methods

In fall 1972, 32 permanent strip plots (1/2 x 10 chains) were established on 4 lines in a systematic design within a 320-acre area (Figure 5). Starting at the northwest corner of the survey area, the first line was established at a bearing of 170 degrees, line 2, 350 degrees; etc. The center lines of plots were marked with stakes at 100-foot intervals to help locate the plots in future years. Strip plots were used because we expected mortality to be relatively low, and we wanted to reduce between-plot variation. Mountain pine beetle caused tree mortality was recorded by diameter and tallied in one of three categories: currently infested trees (1972 attacks), "faders" (1971 attacks), previous mortality (all trees killed before 1970). Only trees larger than 5.5 inches in d.b.h. were recorded. Boles of all beetle-killed trees were marked with metal tags to show year of attack. Each autumn following the initial survey, each strip plot was resampled to record number of new attacks.

In 1975, annual sampling was terminated. This approach of yearly surveys and rechecks provided an annual estimate trees killed from 1970 to 1975. During the initial survey, a variable radius plot (10 BAF) was located in the center of each 10-chain strip plot on which species and size of live trees were recorded.

Results

Green stand structure and species composition in the study area before the MPB outbreak, was reconstructed using green stand and mortality data from the original survey (Table 2, Figure 6). The stand was predominantly lodgepole pine (116.0 trees/acre) with about 4.6 whitebark pines per acre. Non-host species included subalpine fir (9.7 trees/acre) and spruce (0.5 trees/acre).

Cumulative MPB-caused mortality during the infestation was about seven trees per acre. This represents a 5.4 percent loss in stems per acre. Lodgepole pine suffered the greatest loss with 6.3 trees per acre killed. Whitebark pine mortality averaged 0.7 trees per acre (Table 3).

Peak tree killing of both host species occurred in 1971, the second year of the infestation. Following the peak, mortality declined each year until the infestation subsided in 1975. Ninety-five percent of the original stand had survived up to this point.

Outbreak Trend After 1975

McGregor and others (5) documented MPB spread in Yellowstone National Park from 1970 to 1984. The infestation started in the Bechler River drainage in 1965 and spread north and east through an extensive portion of the Park. More than 900,000 acres were infested by 1981. The infestation declined substantially by 1984 (see Appendix).

Although initial surveys showed the infestation declined in the Bechler Meadow plot in 1972 and the Split Creek plot in 1975, aerial survey records showed tree mortality resurged from 1979 to 1983—especially in high-elevation stands around the Split Creek plot.

Figure 5. Location of Split Creek Sample Area in Yellowstone National Park.

Green Stems Per Acre

Diameter Class	Lodgepole Pine	Whitebark Pine	Subalpine Fir	Engelmann Spruce	Total
6	7.96	1.59	3.18	---	12.73
7	7.02	---	1.17	---	8.19
8	7.22	---	.90	---	8.12
9	8.55	---	.71	---	9.26
10	9.74	---	---	---	9.74
11	11.02	.47	.95	---	12.44
12	11.33	.46	.40	---	12.19
13	10.42	---	1.02	---	11.44
14	9.54	.95	.59	---	11.08
15	11.71	.32	---	---	12.03
16	6.52	.12	.22	---	6.83
17	6.17	---	---	---	6.17
18	3.40	.06	---	---	3.46
19	1.46	.06	.16	---	1.68
20	1.83	.14	.29	---	2.26
21	.78	---	---	---	.78
22	.24	.18	.12	---	.54
23	.35	.06	---	.11	.52
24	.59	---	---	---	.59
25	.06	---	---	---	.06
26	---	.09	---	.09	.18
27	---	---	---	---	---
28	.06	---	---	---	.06
29	.07	---	---	.07	.14
30	---	---	---	---	---
31	---	---	---	---	---
32	---	---	---	.06	.06
33	---	.05	---	.05	.10
34	---	---	---	---	---
35	---	---	---	.05	.05
36	---	---	---	---	---
37	---	---	---	.04	.04
Total	**116.04**	**4.55**	**9.71**	**.47**	**130.77**

Table 2. Pre-outbreak stand structure and composition in the Split Creek Survey Area, Yellowstone National Park, 1969 (10).

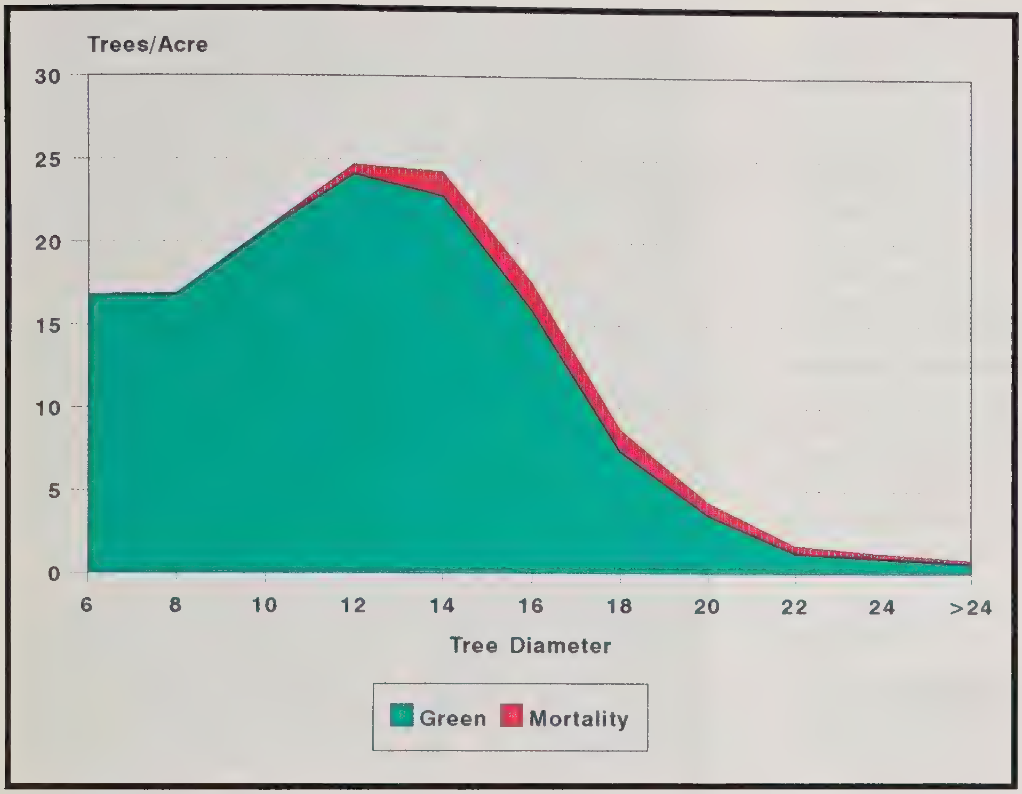


Figure 6. Cumulative tree mortality by 2-inch diameter class near Split Creek.

Yellowstone Fires in 1988

It is well known that MPB and fire play an important role in the regeneration of lodgepole pine in the Rocky Mountains (6 and 9). Unmanaged, over-mature stands, become most susceptible to the beetle after age 80 and large outbreaks develop when forests reach this age over extensive areas. The large number of resulting dead trees increases fuel loading which can lead to large, uncontrollable wildfires when dry, warm, and windy weather occurs. Both dead and remaining live trees are destroyed where intense fires occur, and the resulting openings provide for the development of the next generation of trees.

The natural role of beetle outbreaks and wildfire in the lodgepole pine cycle occurred on a grand scale in Yellowstone National Park in summer 1988. A total of 562,350 acres of forest were affected—this represents over 25 percent of the total area in the Park (4). Total area burned, including meadows and grasslands, was over 1.4 million acres. The scope of the situation can be clearly seen on a satellite photograph taken on September 8, 1988 (cover). The fires, while destroying the old and beetle-damaged forests, set the stage for the development of new, even-aged stands of lodgepole pine. However, the fires drastically changed the appearance of the Park, and many people were upset with management policies which they incorrectly believe were responsible for the event. The regeneration of whitebark pine stands at higher elevations will be a more long-term process. Not as aggressive as lodgepole pine, whitebark pine does not regenerate as quickly in burned areas. The extent of whitebark pine forests affected by fires is unknown, but it is believed to exceed 15 percent. Other tree species, shrubs, and other vegetation will be more abundant in burned stands.

	Dead Trees	
Year	Lodgepole Pine	Whitebark Pine
1970	0.38	---
1971	2.01	0.36
1972	1.77	0.18
1974	0.74	0.06
1975	0.19	---
Total	**6.29**	**0.72**

Table 3. Total number per acre of trees killed by the Mountain Pine Beetle in the high-elevation plot in Split Creek, 1970-75 (10).

Follow-up Sampling

Bechler Meadows

Methods

In 1990, we attempted to sample live trees on the same 27 plots used during the original survey. Although the center of plot number one was located, no other lines could be found. We were able to find tree stumps and cut logs sampled for the beetle attack and emergence study (3); thus, we started our followup sampling within a few feet of the original northeast corner of the Bechler Meadow study area. Stumps and cut trees were observed near most sample points, but no other evidence of sampling was found (Figure 7). Live and standing-dead trees were sampled on 27 variable plots (10 BAF). Nine plots were located at 20-chain intervals on lines 1, 3, and 5. The lines were 20 chains apart. Trees were recorded by 2-inch diameter classes for trees above 5 inches in d.b.h.

Figure 7. Section of the tree was felled for a beetle attack and emergence study (3), Bechler Meadow Trend Plot.

Results

In 1990, 18 years after the beetle outbreak subsided, there was a total of approximately 184 live trees per acre (Table 4). Most remaining trees were smaller than 12 inches d.b.h. Few larger trees survived the beetle outbreak. Trees were evenly distributed within the survey area, and they appeared to be relatively healthy.

An average of 33 dead trees per acre were still standing. Trees that had fallen were not sampled because there was considerable variation in the level of decay and year of attack could not be determined. Dead trees in contact with the ground were heavily decayed, but those off the ground were mostly sound. Although more than 20 trees per acre had fallen, we experienced little difficulty in walking through the area. Many of the standing dead trees were along the edges of meadows, and it appeared that a higher percentage of the dead trees within stands had fallen over.

Diameter Class in Inches [1]

	6	8	10	12	14	16	>16	Total
Live	71.7	60.5	36.7	12.3	1.7	0.8	0.6	184.3
Dead	7.8	11.4	8.2	2.8	1.1	0.9	0.7	32.9
Total	**79.5**	**71.9**	**44.9**	**15.1**	**2.8**	**1.7**	**1.3**	**217.2**

[1] Average values

Table 4. Number per acre of live and standing dead lodgepole pines in the Bechler Meadow Survey Area, Yellowstone National Park, 1990.

Discussion

Data from the 1990 survey are not directly comparable to the results of the initial survey from 1966 to 1972. In 1972, a total of about 156 trees per acre above 5 inches d.b.h. were alive after beetle outbreak. About 184 were present in 1990. The increase of 28 live trees per acre apparently resulted from trees below 5 inches in diameter increasing in diameter over the 18 years. Trees above 5 inches in diameter also moved

into larger diameter classes. A comparison of the 6, 8, 10, and 12 inches diameter classes shows an overall increase of about 27 trees per acre from 1972 to 1990, which indicate that the results of the follow-up survey is relatively close to the initial survey results.

A comparison of the live trees recorded in 1972 (Table 1) and 1990 (Table 4) indicate that little, if any, additional tree losses occurred due to the MPB. However, aerial survey records reported by McGregor and others (5) show that some losses occurred in the Bechler Meadow area in 1973, 1980, and 1981. If tree losses occurred after 1972, we believe they were minimal, and the major effects from the insect outbreak occurred from 1966 to 1972.

We were surprised that more than half the trees killed from 1966 to 1972 were still standing in 1990. As previously noted, more dead trees remained standing on the edges of meadows than within stands. One explanation for this difference would be that the trees on the edges of meadows had more extensive root systems than those within stands.

Overall, tree mortality and remaining snags in this area show that the consequences of an outbreak are not as severe in some areas as some believed in the late 1960's. We found the following statement in a brochure developed on the Targhee National Forest (11):

"Without control effort, bark beetle infestations may run rampant for years, killing from 50 to 90 percent or more of all mature lodgepole pine trees in a stand, eventually resulting in masses of fallen snags. These practically eliminate the stand from timber harvesting, prohibit big game and livestock movement and greatly increase the cost of trail, road, telephone line maintenance and fire suppression."

The down and standing snags in the Park would not result in these drastic effects if a similar situation occurred on National Forest System lands. There is no question; however, that the increased fuel loading from the beetle-killed trees has made the remaining lodgepole pine forest more susceptible to wildfires (Figure 8).

Figure 8. Fallen snags in the Bechler Meadows Survey Area in August 1990.

Split Creek

Methods

We were unable to locate the starting point at the northwest corner of the Split Creek survey area. The plot was marked on a 1966 aerial photograph, but the appearance of the landscape by 1990 had changed considerably. Beetle-damaged stands had been extensively logged up to the Park boundary, and a large fire in 1988 had destroyed the forest close or within where the survey area appeared to be located (Figure 5). Since the site is on a relatively flat plateau, subtle topography features were of little help. Also, we were unable to find any remaining evidence related to the initial surveys—including a painted reference tree, wood stakes marking the center line of strip plots, metal tags nailed at about 5 feet above the ground marking trees killed by the beetle from 1970 to 1975, and blazes on beetle-killed trees. Nevertheless, we believed we were sampling within or close to the original 320-acre tract. We later discovered, using aerial photography taken in 1990, that the forest had been destroyed in the northern half of the survey area during the 1988 wildfires in the Park. Thus, we sampled the southern half of the original area and about 160 acres to the immediate south of the plot.

Thirty-two variable radius plots (10 BAF) were sampled in 1990. Eight plots were located on 4 lines on a 10-chain grid. All live trees and standing snags, 5 inches in diameter and larger, were recorded.

Results

A total of approximately 154 live trees per acre were recorded (Table 5). Lodgepole pine was the most abundant species, comprising 77 percent of the stand. A relatively large number of lodgepole pines greater than 10 inches d.b.h. survived the outbreak. Whitebark pine made up only about 4 percent of the live trees, and most the of trees were in 6-inch diameter class. No live whitebark pines greater than 10 inches d.b.h. were recorded. Alpine fir comprised about 18 percent of the stand.

Sixty-nine dead lodgepole pines per acre were still standing in 1990. Overall tree mortality was much higher, however, because snags that had fallen over were not recorded. The dead trees on the ground were common throughout the sample area (Figure 9). No standing whitebark pine snags were recorded.

Discussion

There was an average 131 trees per acre recorded during initial surveys, and 223 trees per acre in 1990. Since only half of the original tract was resurveyed, only a limited inference can be reached by comparing the results of the initial surveys (Table 2) with the follow-up survey (Table 5).

Tree mortality recorded during the follow-up survey show that MPB caused heavy trees losses after 1975. McGregor and others (5) recorded tree losses at this site from 1979 to 1983. Although the same 320-acre tract was not surveyed, we believe the infestation trend was similar in nearby stands. It appears that climatic conditions at this high-elevation site did not impair the beetle and result in reduced tree losses.

Figure 9. Down snags in the high elevation site near the Split Creek Plot.

Diameter Class, Inches [1]	Lodgepole Pine Live	Lodgepole Pine Dead	Whitebark Pine Live	Whitebark Pine Dead	Subalpine Fir Live	Total
6	14.3	---	4.8	---	9.5	28.6
8	9.8	2.7	0.9	---	9.0	22.4
10	24.1	12.6	0.6	---	5.2	42.5
12	24.3	16.3	---	---	2.0	42.6
14	17.5	12.0	---	---	1.8	31.3
16	12.3	10.5	---	---	0.9	23.7
18	9.9	8.1	---	---	0.2	18.2
>18	7.2	6.8	---	---	0.1	14.1
Total	**119.4**	**69.0**	**6.3**	**---**	**28.5**	**223.4**

[1] Average values.

Table 5. Number per acre of live and standing dead lodgepole pine and whitebark pine and live subalpine firs in the Split Creek Survey Area, Yellowstone National Park, 1990.

Conclusions

Long-Term Studies

The decision to locate the trend plots in Yellowstone National Park proved to be fortunate. Had they been established on the Targhee National Forest near the Park boundary, as originally planned, the forest stands most certainly would have been altered or removed during sanitation and salvage logging operations. Extent of timber harvesting on the Forest is clearly visible in a satellite photograph (cover) along with western boundary of the Park. Beetle-damaged stands in the Park were and continue to be vulnerable to destruction by wildfires or other natural events, but they will not be altered through timber harvesting.

We never envisioned that we would sample both sites for more than 5 to 6 years; thus, we did not use more costly metal or plastic stakes, etc., to mark plot centers. In hindsight, this was an unwise decision, especially in the Split Creek plot where no evidences of plot marking was found. Also, a permanent reference point, such as a metal fence post with a metal sign, would have remained, even after the wildfire destroyed the northern half of the Split Creek tract.

The location of both plots are marked on historical aerial photographs in Figures 10 and 11 for long-term documentation. Aerial photographs taken in 1990 are provided for both plots to show the various changes that occurred over 30 years in Bechler Meadows and 20 years in the Split Creek area.

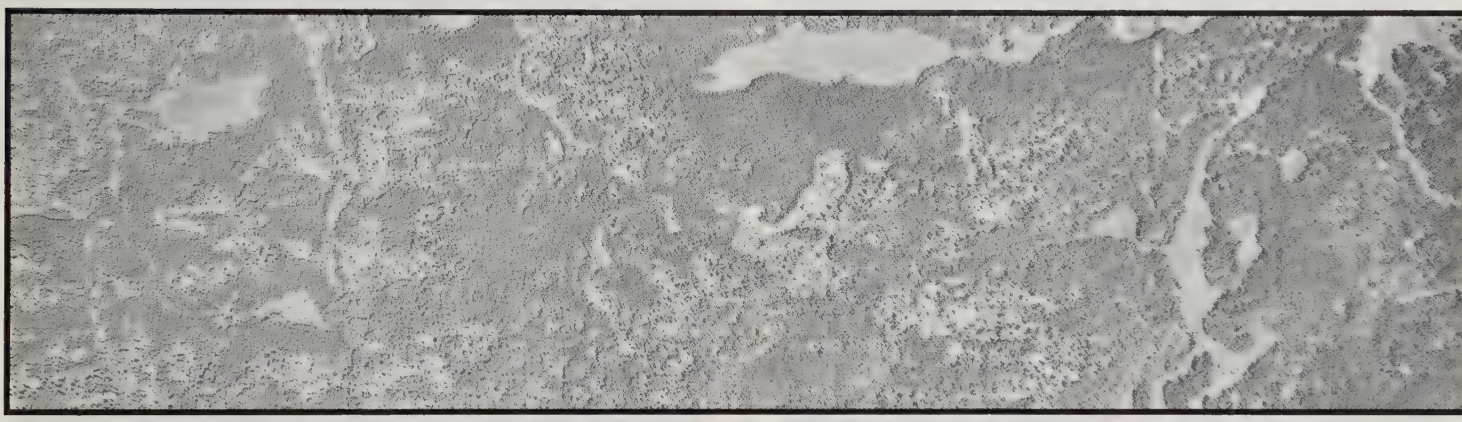


Figure 10. Aerial photographs of the Bechler Meadow Survey Area showing forest conditions in the survey area prior to the Mountain Pine Beetle outbreak on August 3, 1959, EGS-8-25, scale 1:15,840 (Above); and after the outbreak on August 28, 1990, 389-18, scale 1:24,000 (Below).

Figure 11. Aerial photographs of the Split Creek Survey Area showing forest conditions in the survey area prior to the Mountain Pine Beetle outbreak on August 13, 1969, ETZ-1-26, scale 1:15,840 (Above); and after the outbreak on August 28, 1990, 389-33, 1:24,000 (Left).

Effect of Elevation on Tree Losses

We incorrectly believed, as did most foresters and entomologists in the 1970's, that beetle-caused tree mortality would be higher in the low-elevation sample area. Tree mortality was high in this area; almost 56 trees per acre were killed by the MPB from 1966 to 1972. However, follow-up survey results from the high-elevation site indicate that tree mortality was much more severe. A total of 69 beetle-killed trees were still standing. Although down snags were not sampled, we suspect that over 20 snags per acre, killed during the outbreak from 1970 to 1983, had fallen over (Figure 7). We do not know the total extent of tree losses, but it is obvious climate did not limit beetles' biology and reduce tree losses. There were more larger diameter trees in the high elevation stands, and this factor may have favored the beetle and led to the heavier tree losses.

Health of Remaining Forests

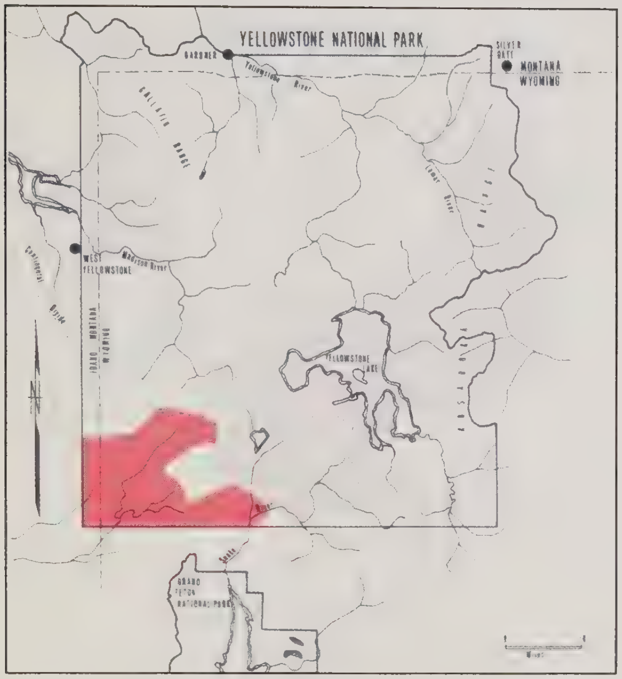
We did not evaluate the relative health of live trees remaining at either sample site. The lodgepole pines in the Bechler Meadows area appeared to be relatively healthy, and trees continued to increase in diameter. The trees at the Split Creek site did not appear to be as healthy. Trees in the high-elevation areas are subjected to more severe weather conditions. They also may have been older than those at lower elevations and less capable of responding to thinning by the MPB. Whatever the reason, it would be informative to evaluate relative health and recovery of those forests in the years to come.

Fire Hazard

The fuel loading from the beetle-killed trees is still high in both sides, and the remaining forests are probably still susceptible to being destroyed by wildfires. We do not know how long it will take before the dead trees are decomposed sufficiently to reduce the fire hazard, but it possibly could take several decades. This is another aspect that might be worthwhile to examine in the future.

Appendix

Chronology of Mountain Pine Beetle infestation, Yellowstone National Park, Wyoming, 1970-1984.



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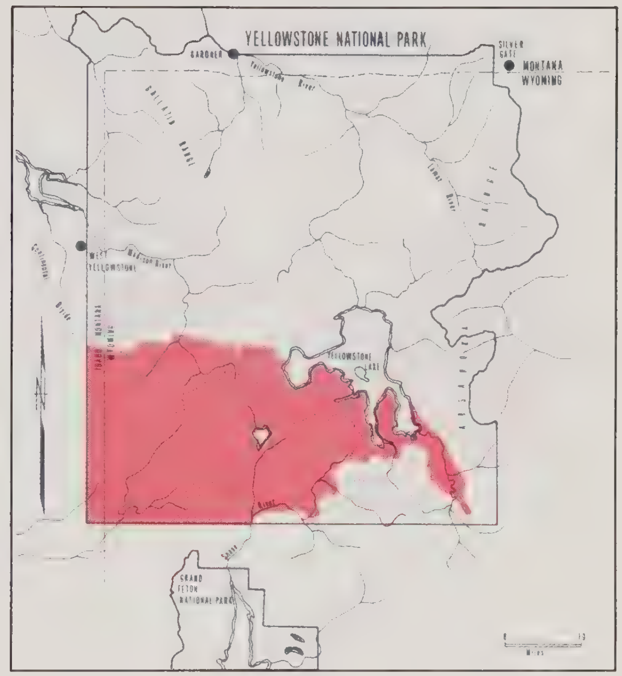

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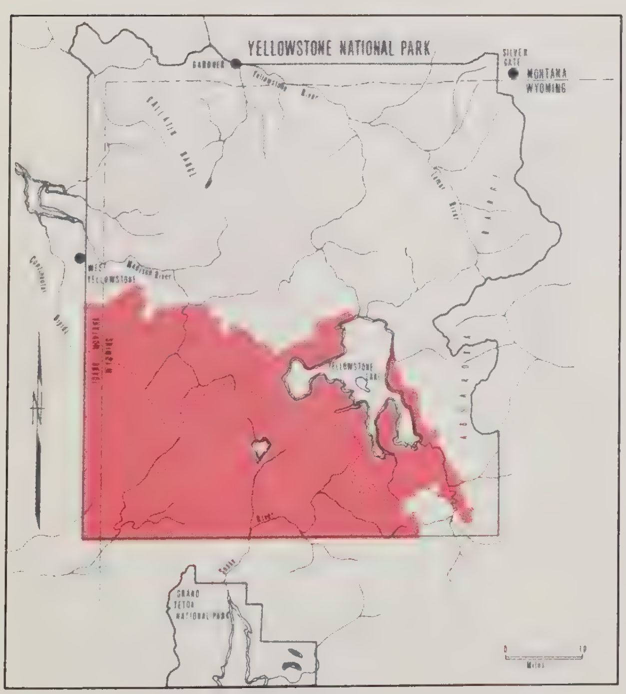

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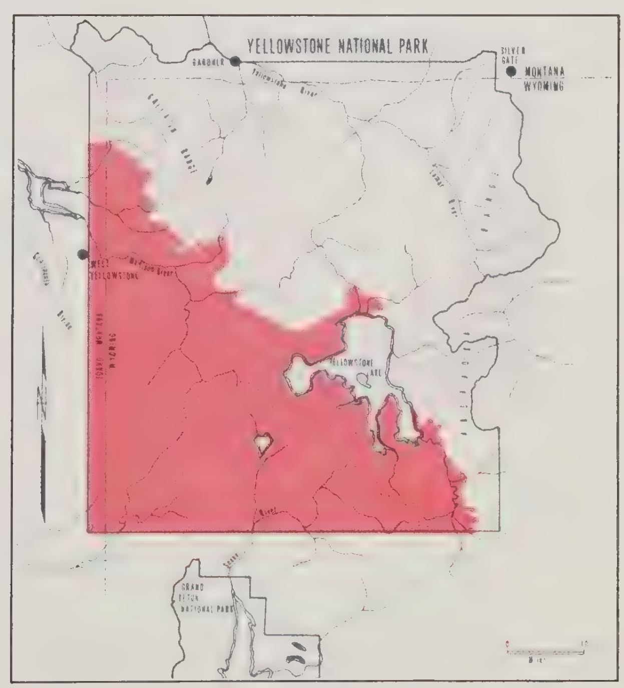

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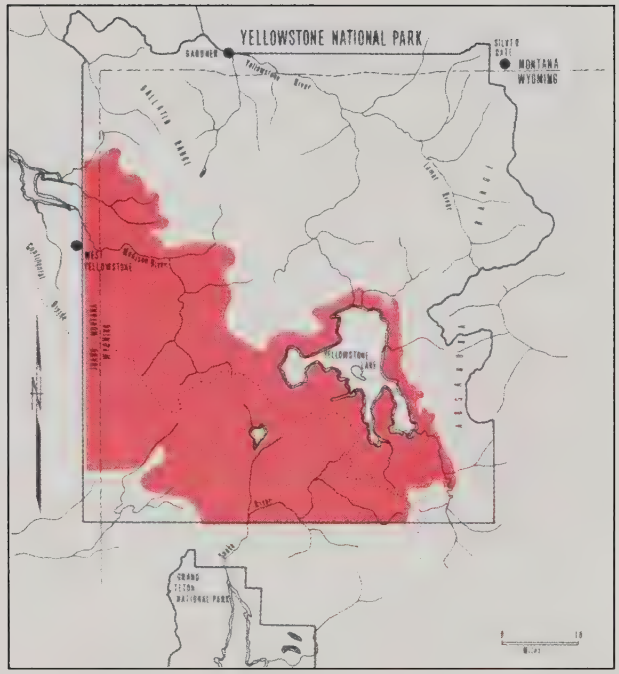

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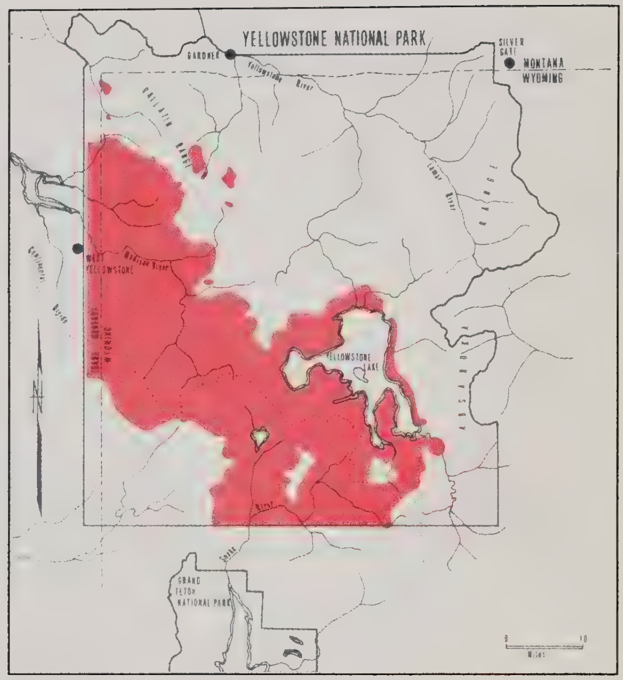

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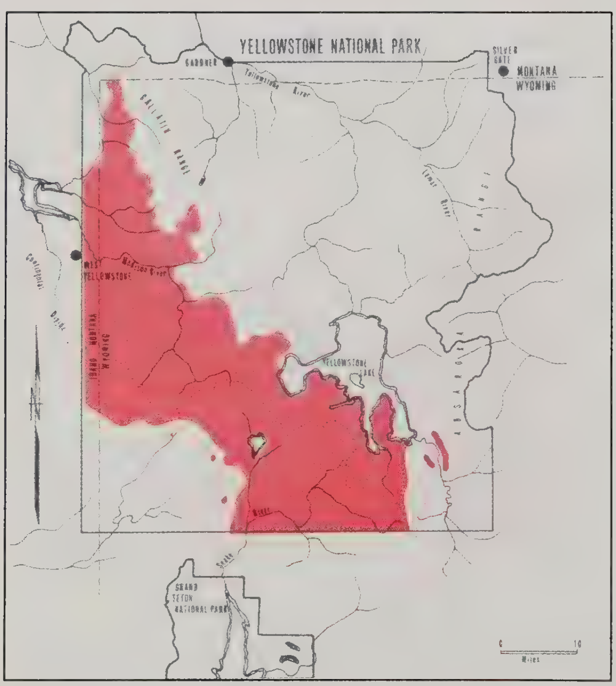

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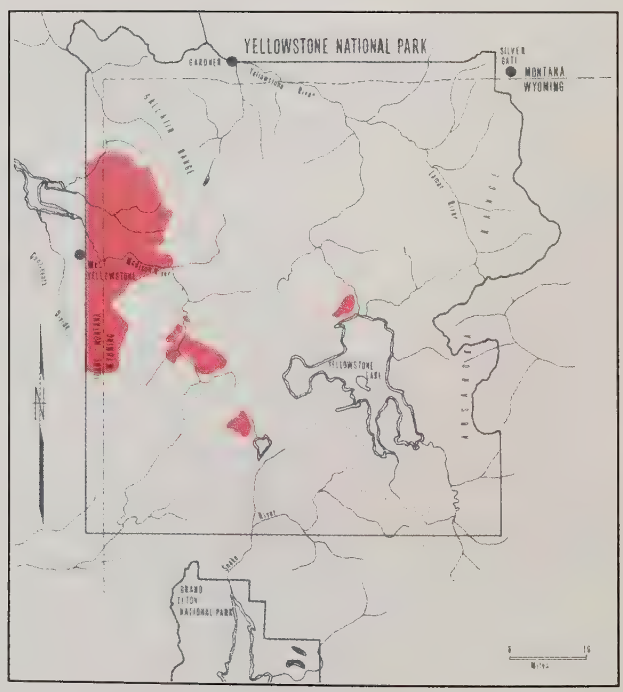

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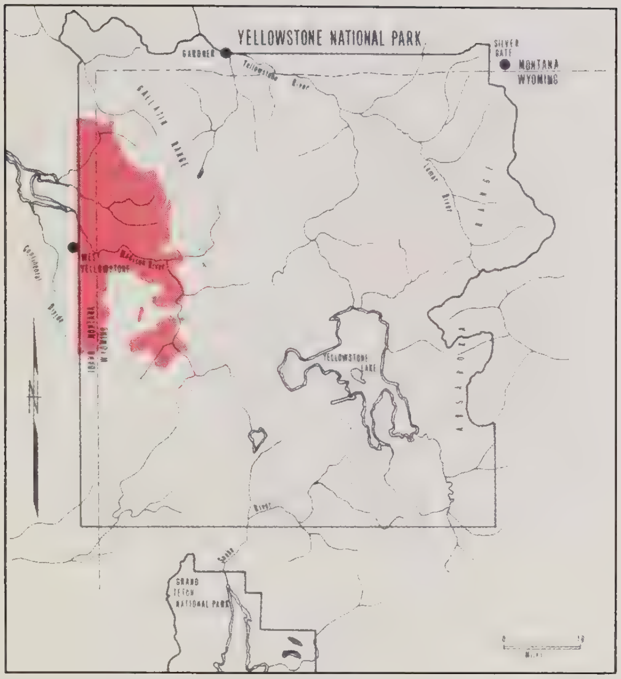

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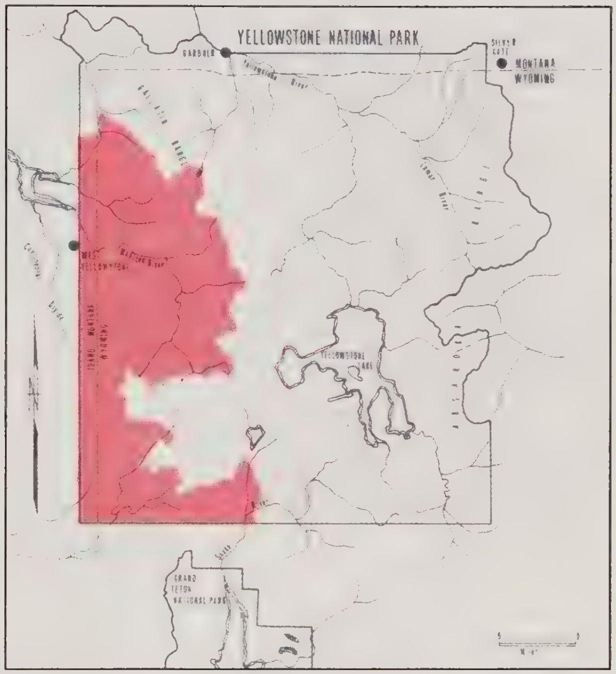

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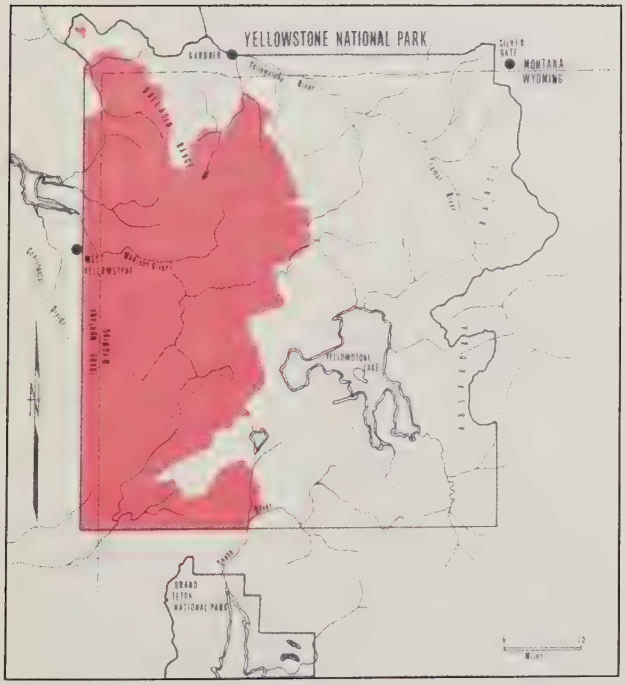

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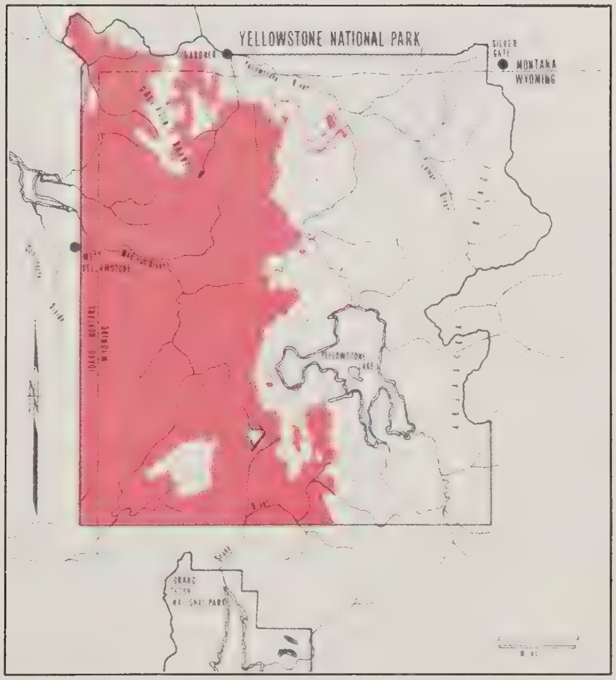

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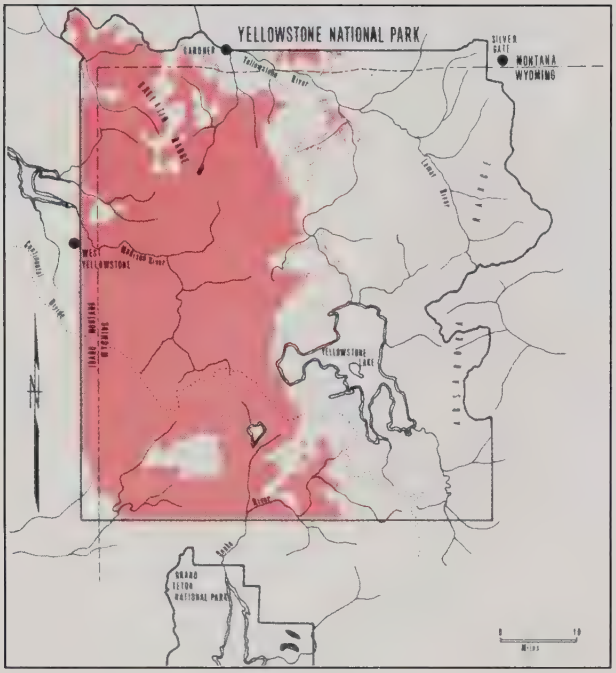

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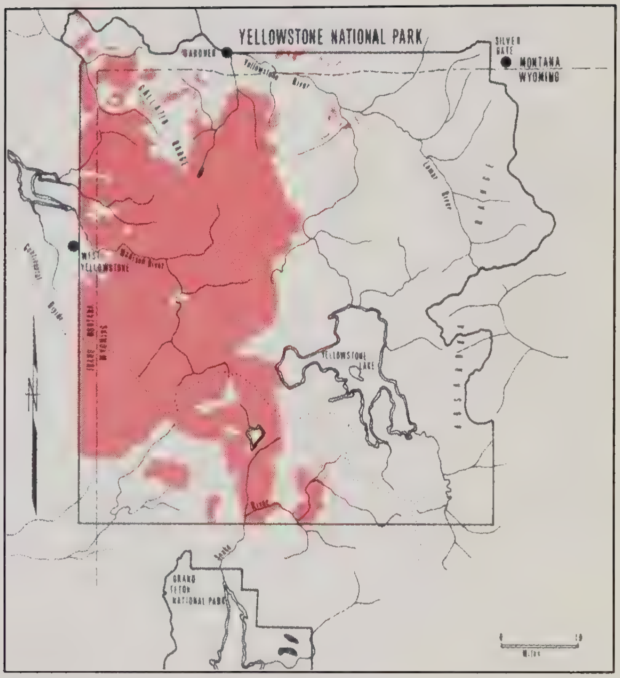

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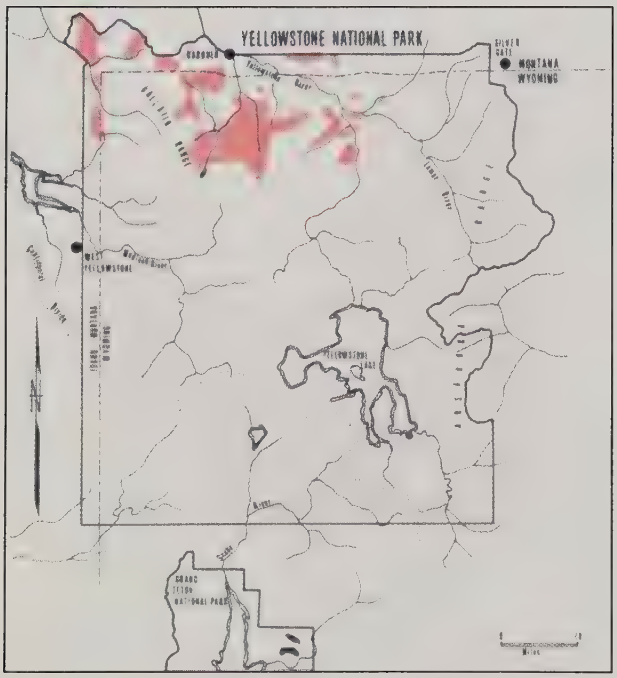

1984

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